DIFFERENCES IN ANTHROPOMETRIC PARAMETERS OF 4-6 YEAR OLD CHILDREN SEEN IN A NORTHEASTERN OKLAHOMA PEDIATRIC CLINIC

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CHAPTER I

INTRODUCTION

Childhood overweight is a major health concern worldwide (Ogden et al., 2006). Over the past thirty years, the prevalence of overweight and at-risk for overweight in children has tripled in most countries (Plourde, 2006). Worldwide, approximately 155-200 million children ages five to seventeen years and an additional 22 million under the age of five are either obese or overweight (Malecka-Tendera & Mazur, 2006; Plourde, 2006).

The prevalence of childhood overweight is a major concern in the United States (US) where the rate of overweight is the highest of all developed nations (National Center for Health Statistics, 2007). Childhood overweight has doubled in children ages 2-5 years and tripled in both school age children and adolescents (American Academy of Pediatrics, 2003). Oklahoma currently ranks as the thirteenth most obese state in the nation with 26.8% of Oklahoma adults being obese compared to 24.4% nationwide (Department of Health and Human Services & Centers for Disease Control and Prevention, 2005). Tulsa and Oklahoma City have been listed as one of the top 25 most obese cities in America (American Obesity Association, 2005).

Economic burdens arise when children develop adult lifestyle diseases due to childhood overweight (Daniels, 2006). While national pediatric costs of overweight are difficult to assess, research shows that obese adults under age 65 spend 36% more on health issues compared to their normal weight peers (Kibbe & Offner, 2003). Hospital admissions are also increasing among overweight children and adolescents (Wang & Dietz, 2002). From 1997 to 1999, the nationwide average cost per year for weight related hospitalization expenses in children and adolescents aged 6-17 years was approximately $127 million, more than three times the adjusted medical expense in 1982 on hospital admissions alone (Cash et al., 2004; Wang & Dietz, 2002). In 2003, the nationwide adult weight-related medical costs were estimated to be $75-117 billion or 31% of total medical costs {Department of Health and Human Services, 2005 #400; (Cash et al., 2004; Kibbe & Offner, 2003). In 1999, Oklahomans spent $854 million on adult-weight related medical cost (Cash et al., 2004; Department of Health and Human Services & Centers for Disease Control and Prevention, 2005; Kibbe & Offner, 2003).

Adult onset health issues such as hypertension, atherosclerosis, type 2 diabetes (T2DM), nonalcoholic fatty liver disease, polycystic ovary disorder (PCOS), pulmonary conditions (e.g., asthma, obstructive sleep apnea,), gallbladder disease, growth acceleration, dyslipidemias, musculoskeletal problems, and psychosocial issues are increasingly prevalent among overweight children (American Academy of Pediatrics, 2003; Barlow, Dietz, Klish, & Trowbridge, 2002; Burke, 2006; Canty, 2003; Daniels, 2006). Overweight children are at a three to ten fold risk for hypertension, three to eight fold risk for dyslipidemias, four to six fold risk for obstructive sleep arousal and twice the risk of T2DM as compared to normal weight children (Canty, 2003; Harrell, Jessup, &

Greene, 2006; Kibbe & Offner, 2003; Ogden, Flegal, Carroll, & Johnson, 2005). Fifty percent of obese children remain obese as adults (Cash et al., 2004; Plourde, 2006). Increased morbidities in adolescents is increased even when weight is lost during adulthood (Haas et al., 2003).

Purpose

This descriptive retrospective study was conducted to evaluate the prevalence of overweight and at-risk for overweight in 4-6 year old children seen in a northeastern Oklahoma pediatric clinic. This study evaluated if there were differences in the distribution of children in the four weight categories of underweight, normal weight, at-risk for overweight, and overweight by gender, insurance type or biennial exam year category. This study also evaluated if there was a difference in this cohort of children by body mass index (BMI) *z*-scores by gender, insurance type or biennial exam year category. The findings of this study are the first step toward the development of programs and services to better serve families of overweight children.

Objectives

1. To determine BMI percentiles and BMI *z*-scores of 4-6 year old children seen from 1999-2006 at a northeastern Oklahoma pediatric clinic.
2. To determine if there is a difference in the distribution of underweight, normal weight, at-risk for overweight and overweight in this cohort of children by gender, insurance type and biennial exam year categories.

Null Hypotheses

Ho1. There will be no significant difference in the distribution of children classified as underweight, normal weight, at-risk of overweight, and overweight by gender, insurance type or biennial exam year category.

Ho2. There will be no significant difference in children's BMI z-scores by gender, insurance type, or biennial exam year category.

Assumptions and Limitations

Because all the children were patients treated by the same doctors, it was assumed that similar nutritional information was received during the course of the child's medical care. During these children's life span, the clinic employed a part-time wellness consultant who met with parents beginning at the birth of the child to provide education on health and wellness issues. It is assumed that the parents of these children had opportunity to view displays on health-related issues and receive health and weight information at well check ups which may impact their weight status.

This study had several limitations. The use of insurance as a parameter which might affect weight was based on a study by Haas et al ((Haas et al., 2003)). They showed that lacking health insurance or having public insurance (government assisted) were found to be positively associated with increased prevalence of overweight in adolescents (Barlow, Bobra, Elliott, Brownson, & Haire-Joshu, 2007). However, without a questionnaire to validate insurance type, the verification of insurance category was an unexpected challenge (Barlow et al., 2007; National Center for Health Statistics, 2007). The medical charts that we have examined were family charts in which some families have different insurance for some children and a few families had more than one form of insurance. Government-assisted medical care included but was not limited to Department of Health and Human Services (DHHS) custody, foster care, or Sooner Care. Another limitation of this study was the small number of uninsured 'self-pay' and 'government-assisted' children. From 1999-2006, the clinic normally had 16-18% of the children on government-assisted medical care yet only 7.5% received a kindergarten checkup. During the same time frame, uninsured children comprised 20-22% and there was also a low turn out (6.9%) for the kindergarten checkup. The ratio of children in different insurance categories was a major limitation of this study and invalidated some important statistical analyses.

Abbreviations

Adult Treatment Panel III (ATP III)

American Academy of Pediatrics (AAP)

American Obesity Association (AOA)

Behavioral Risk Factor Surveillance System (BRFSS)

Blood Pressure (BP)

Body Mass Index (BMI)

C-reactive protein (CRP)

Centers for Disease Control and Prevention (CDC)

Department of Health and Human Services (DHHS)

Dual Energy X-ray Absorptiometry (DEXA)

General Linear Model (GLM)

Glycosolated Hemoglobin ($Hb_{A1c)}$

High Density Lipoprotein (HDL)

Impaired Fasting Glucose (IFG)

Impaired Glucose Tolerance (IGT)

International Obesity Task Force (IOTF)

Low Density Lipoprotein (LDL)

National Center for Health Statistics (NCHS)

National Health Examination Survey (NHES)

National Health and Nutrition Examination Survey (NHANES)

National Institute for Health Care Management (NIHCM)

National Heart, Lung and Blood Institute (NHLBI)

National Longitudinal Study of Adolescent Health (Add Health)

Pathobiologic Determinants of Atherosclerosis in Youth (PDAY)

Polycystic Ovary Syndrome (PCOS)

Standard Deviation (s.d.)

Statistical Analysis System (SAS)

Study of Perth Lifestyle and Skin Health (SPLASH)

Socioeconomic Status (SES)

Type-2 Diabetes Mellitus (T2DM)

United States (US)

Waist Circumference (WC)

Women Infants and Children (WIC)

CHAPTER II

REVIEW OF LITERATURE

<u>Prevalence of Pediatric Overweight</u>

America has the highest prevalence of childhood overweight of all developed nations (Division of Nutrition and Physical Activity & National Center for Chronic Disease Prevention and Health Promotion, 2007). Findings from NHANES II (1971-1974) to NHANES IV (2003-2004) showed that overweight has increased from 5.0% to 13.9% for 2-5 year old children and 4.0% to 18.8% for 6-11 year old children **(Table 1)** (National Center for Health Statistics, 2006).

<u>Oklahoma Overweight</u>

The American Obesity Association (AOA) uses the 2002 Centers for Disease Control and Prevention (CDC) Behavioral Risk Factor Surveillance System (BRFSS) statistics to rank the top US cities for overweight and obesity (American Obesity Association, 2005). In 2002, Tulsa was listed as the fourth most overweight city with 64.4% of the population having BMI $\geq$ 25 (American Obesity Association, 2005). The AOA has subsequently ranked Tulsa as the 22nd, 19th, 11th, and 23rd city with the highest ratings for combined overweight and obesity for 2005, 2004, 2002, and 2001, respectively. Oklahoma City was ranked as 23rd and 13th in 2004 and 2000, respectively (Cash et al., 2004).

Economic Impact of Pediatric Overweight

The economic impact of childhood overweight and obesity is difficult to assess. However, estimates can be obtained from data on adults. National spending on overweight and obesity-related medical expenses has been described as rivaling the amount spent on smoking which has been reported to account for 9.1% of total medical spending (Katherine M. Flegal, 2005). In 1999, the Lewin Group commissioned by AOA, reported the direct health care costs of obesity was 102.2 billion dollars or 31% of total medical costs (Kibbe & Offner, 2003). In 2005, Flegal reported the cost of overweight and obesity to be at 3.7% and 5.3% of the total medical costs for adults (Katherine M. Flegal, 2005). Kibbe and Offner (Kibbe & Offner, 2003) reported higher amounts spent on overweight and obesity-related medical expenses. They also reported a 36% increase in inpatient and outpatient spending and 77% increase in medications due to obesity (Kibbe & Offner, 2003).

Gender Differences

BMI-for-age charts are both gender and age specific because the percent of body fat changes between gender as development occurs (National Center for Health Statistics, 2007). There are conflicting reports on the effect of gender on at-risk of overweight and overweight. According to NHANES data from 1999 to 2004, the prevalence of overweight increased from 13.8 to 16.0% and 14.0 to 18.2% in girls and boys, respectively **(Table 2)** (National Center for Health Statistics, 2007; Ogden et al., 2006). In 1999 to 2000, there were more 2-5 year old girls than boys of the same age that were classified at-risk for overweight and overweight. However, in the subsequent year categories (2001-2004), there were more boys than girls who were at-risk for overweight and overweight (Center for Disease Control, 2006). Findings by Gordon-Larsen et al. (Gordon-Larsen, Adair, & Popkin, 2003) disagree with the NHANES data that showed more overweight boys than girls. They found more pronounced weight disparity in females than males (Gordon-Larsen et al., 2003; Haas et al., 2003). Other investigators (Haas et al., 2003; Neumark-Stzainer, Story, Hannan, & al., 2002; Vieweg, Johnston, Lanier, Fernandez, & Pandurangi, 2007) agree with the later data from NHANES showing more boys being at-risk for overweight and overweight. Moore et al. (Moore, Stephens, Wilson, Wilson, & Eichner, 2006) reported that there were no differences in the risk for overweight and overweight in boys and girls.

Measures of Adiposity

Childhood overweight can be defined as a chronic condition which develops when energy intake exceeds energy expenditure resulting in excess body weight or the increase in body weight beyond the limitation of skeletal and physical requirements, as a result of an excessive accumulation of fat in the body (Katherine M. Flegal, Tabak, & Ogden, 2006) Although BMI correlates well with adiposity the use of secondary parameters such as family history, blood pressure, total cholesterol, lipid profiles, and increases in BMI percentile over time are needed to diagnose obesity (Katherine M. Flegal et al., 2006). US expert committees agree that the word obese can be used for both at-risk for overweight children ($\geq$ 85% of BMI) and overweight ($\geq$ 95% of BMI) when confirmed with secondary parameters (Department of Health and Human Services & Centers for Disease Control and Prevention, 2007a).

Parameters for tracking children's weight are numerous including physical exam with medical history, weight-for-age, height-for-weight, BMI, BMI percentile, skinfold thickness, waist circumference (WC) and waist-hip ratio (American Academy of Pediatrics, 2003; Barlow et al., 2002; Katherine M. Flegal, 2005). Although BMI percent has been recommended for tracking childhood overweight, other growth parameters have been used. Each growth parameter has its own strengths and weaknesses. Weight-for-height expresses percent of ideal body weight and can identify growth curves for children 90-137 cm tall, which represents children approximately 2-9 years of age (Barlow et al., 2002). Skin fold measurements and the use of calipers require practice. Moreover, calipers are not always available for health care practitioners (Hirschler, Aranda, Calcagno, Maccalini, & Jadzinsky, 2005). In adults, WC is a good indicator of intra-abdominal fat mass which correlates with cardiovascular disease (CVD) but this relation is unclear in children (Barlow et al., 2002). One disadvantage of WC is that there are no accepted procedures for defining the site for the measurement of WC. Two sites are frequently used: (a) at the natural waist, i.e. mid-way between the tenth rib (the lowest rib margin) and (b) the iliac crest and at the umbilicus level (Barlow et al., 2002; Kibbe & Offner, 2003). Moreover, there are no national norms to compare WC and waist-to-hip ratio for children (Gibson, 2005).

Population studies of childhood overweight are recommended to be tracked through the use of BMI and placement on the 2000 BMI age and gender specific growth chart as recommended by the American Academy of Pediatrics (AAP), CDC and the Worldwide Health Organization (WHO) (**Figures 1 and 2**). These charts allow tracking trends of overweight and at-risk or overweight using national databases. Individual changes in a child need to be compared only to the child as adjusted by age (National Center for Health Statistics, 2006). Cutoff criteria for overweight and at-risk for overweight are based on 2000 CDC BMI-for-age charts for the United States (Barlow et al., 2002). Cole et al. found BMI percentile to be the best method for tracking short term weight changes in children (Katherine M. Flegal, 2005).

Although BMI percentile has been recommended as the preferred method of office-based assessment since 1998, only 20% of pediatricians, nurse practitioners and registered dieticians use these (Cash et al., 2004; Cole, Faith, Pietrobelli, & Heo, 2005). Weight-for-age is reportedly used in 97% of countries, while weight-for-height was used 23% of countries, and the suggested BMI is rarely used (Daniels, 2006; Kibbe & Offner, 2003).

Development of BMI-for-Age Growth Charts Using BMI %

Researchers agree that BMI is the best method for tracking weight changes in childhood population studies (American Academy of Pediatrics, 2003; Cash et al., 2004; de Onis, 2004). BMI correlates well with accurate measures of body fatness such as dual energy xray absorptiometry (DEXA). Measures of body fatness better reflects obesity as it refers to excess adiposity and not weight (Cash et al., 2004) . In children, body fat accumulates differently among males and female as they mature (Katherine M. Flegal et al., 2006). Children’s BMI is therefore compared to a population of children of the same gender and age by percentile (Barlow et al., 2002; Cash et al., 2004).

To determine BMI in children, BMI is calculated by standard formulas as follows:

$$\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height (m)}^2} \quad \text{(Metric system)}$$

$$= \frac{\text{Weight (lbs) x 703}}{\text{Height (inches)}^2} \quad \text{(English system)}$$

BMI values are then plotted on gender specific BMI-for-age charts **(Figures 1 and 2)** and the percentile range recorded. Weight categories as defined by BMI percentile are used with children as absolute BMI values cannot be used because gender differences occur during development (Cash et al., 2004; Katherine M. Flegal, 2005). Easy to read BMI percentiles are marked at the 3^{rd}, 5^{th}, 10^{th}, 25^{th}, 50^{th}, 75^{th}, 85^{th}, 95^{th}, and 97^{th} percent on these charts. Weight status can be described as occurring "at", "near", "above", "below" or between two percentiles. Weight status can also be reported by four weight categories: less than the 5^{th} percentile is considered underweight, normal weight is from the 5^{th} up to the 85 percentile, greater than or equal to 85% is considered at-risk for overweight and greater than or equal to 95% are overweight (Katherine M. Flegal, 2005).

The 2000 CDC reference growth charts were developed from several national population studies. Statistical data for childhood overweight and at risk for overweight were obtained from National Health Examination Survey (NHES) I (1960-1962), NHANES I (1971-1974), and NHANES II (1976-80) **(Table 1)** (American Academy of Pediatrics, 2003; Katherine M. Flegal, 2005; National Center for Health Statistics, 2006). CDC scientists left out data from NHANES III (1976-1980) when developing the 2000 CDC reference growth chart because they saw an unexpected increase from NHANES II (1976-1980) to NHANES III (1988-1994) of overweight in children aged six and above

(Katherine M. Flegal et al., 2006). The currently used 2000 CDC growth charts are revisions of the 1977 National Center for Health Statistics (NCHS) (de Onis, 2004).

Challenges of Childhood Weight Classification

Interpretation of childhood overweight assessment in the literature is not straightforward (Katherine M. Flegal et al., 2006). Terminology varies between studies (Katherine M. Flegal et al., 2006). Some researchers interchangeably refer to categories of overweight and obesity while others use at-risk for overweight and overweight (Katherine M. Flegal et al., 2006). Additionally, the meaning of the above terms varies between countries (Kibbe & Offner, 2003). **Table 3** summarizes the weight categories used in adults and children (Kibbe & Offner, 2003).

Clarification of weight assessment is seen in **Figure 3** which shows a BMI of 23 can mean different weight categories depending on the age of the child. A BMI of 23 will be overweight category for a 10 year old boy but would be in the healthy category for a 15 year old boy. **Figure 4** shows a boy at age ten in each of the four weight categories having different BMIs, thus showing the importance of BMI-for-age percentile charts.

Another challenge facing researchers working in the area of obesity is the possible skewing of the population mean between years of data collection. The 2000 CDC reference underestimated the weight-for-height *z*-scores of individual children compared to 1977 NCHS growth chart (de Onis, 2004). A child closest to the 3rd standard deviation (s.d.) in 1977 would be below the 2nd standard deviation in the 2000 CDC charts (de Onis, 2004). A *z*-score of +10.7 s.d. in 1977 will be below +4 s.d. in the CDC 2000 charts (de Onis, 2004). If today's children were placed in the 1977 NCHS, it will underestimate the true rate of childhood overweight and obesity (Katherine M. Flegal, 2006).

CDC researchers agreed that comparisons were needed between national studies since BMI have become higher over time (Katherine M. Flegal, 2005). CDC found the currently used definition of overweight/obesity in adults did indeed show a high prevalence of obesity when applied to the older data sets. However, data for children was limited (K. M. Flegal & Troiano, 2000). NHES II (1966-1965) was limited to children 6-11 years and NHES III (1966-70) was limited to children ages 12-17 years (K. M. Flegal & Troiano, 2000). CDC researchers compared earlier studies to NHANES III by Tukey mean-difference plots with single year exam periods (K. M. Flegal & Troiano, 2000). Every even percentile was examined and for children both the mean and median BMI and the prevalence of overweight or obesity was greater in NHANES III (K. M. Flegal & Troiano, 2000). This study showed clearly that BMI values of children in NHANES III were statistically greater that previous NHANES and NHES data. It also showed the differences in the lower percentiles were very close to zero and the differences increased progressively toward the upper end of the distribution (Scheier, 2004).

Another limitation of BMI is it's use relative to gender and ethnicity which can place a child in more than one weight category depending on how they categorized the data (U.S. Preventative Services Task Force, 2006). BMI is unable to distinguish between increased fat mass from fat-free mass especially in non-Hispanic.

BMI *z*-scores

Z-scores are statistical methodologies for standardization of a population. Commonly referred to as normal score, the *z*-score is derived by subtracting the mean from the raw score and dividing the difference by the standard deviation (Golley, Magarey, Baur, Steinbeck, & Daniels, 2007). In childhood overweight this tool is very useful to compare weight within a local database when no national comparative databases are available (Cole et al., 2005).

BMI can be converted into a *z*-score which is adjusted for age and sex using the US CDC 2000 growth reference. BMI *z*-score is useful for cross-sectional adiposity measurement and good to compare growth patterns of a child to a cohort of children (Cash et al., 2004; Cole et al., 2005). It must be noted that BMI *z*-scores and BMI% attenuate larger fatter children (Cole et al., 2005).

BMI *z*-scores might also be used within a disease process to determine rate of severity such as with metabolic syndrome. The BMI *z*-score cutoff point of 2 allows for growth of childhood but greater than 2.5 is an indicator of severe metabolic syndrome (Cash et al., 2004). When BMI *z*-score reaches a severe level of > 2.5, the prevalence of metabolic syndrome is 50% (Katherine M. Flegal et al., 2006).

Data Sets

A challenge of BMI interpretation worldwide is the use of differing data sets (de Onis, 2004). Worldwide, less than one-third of countries monitored growth in children beyond 6 years of age even though WHO recommends the need for yearly assessment of all children up to 18 years of age (de Onis, 2004). Child growth measurements are compared to reference values but reference values change depending on the researcher (de Onis, 2004). AAP recommends the use of the 2000 CDC growth charts from the NCHS while WHO uses worldwide healthy breastfed infants (Katherine M. Flegal, 2005).

The use of differing databases adds confusion to interpretation of international data (Katherine M. Flegal et al., 2006). In many countries, no national database occurs in which to reference BMI data. For example, Australians can use a variety of data sets for comparison such as the International Obesity Task Force (IOTF) reference, CDC reference, and Great Britain reference (Katherine M. Flegal et al., 2006). The WHO have BMI-for-age growth charts for birth to pre-school aged children based on healthy breast fed babies from around the world (Katherine M. Flegal et al., 2006). The 2000 CDC growth charts are recommended for monitoring US children's growth and additional BMI data sets are available to specifically define childhood overweight (Katherine M. Flegal et al., 2006). The IOTF uses cutoff points representative of the adult cutoff of 25 and 30 BMI at age 18 years taken from data in six nationally representative data sets (Katherine M. Flegal et al., 2006). In one analysis, overweight in children came from three data sets which provided similar but not identical references. Cole's IOTF data gives young females lower and older females higher estimates of BMI than either the CDC or the estimates by Must (Katherine M. Flegal et al., 2006; Must, Dallal, & Dietz, 1991)

Descriptive terminology also contributes to confusion. Expert US committees have recommended using BMI-for-age at or above the 95% to screen for obesity in children (Katherine M. Flegal et al., 2006). The IOTF references are similar (Katherine M. Flegal et al., 2006). In the strictest definition, obesity refers to adiposity and overweight refers to excess weight of a standard weight (Katherine M. Flegal et al., 2006). BMI-for-age is recommended for tracking, yet BMI still measures excess weight and may not measure excess fat (Haas et al., 2003). Additional in-depth assessments are required to positively diagnose obesity.

Insurance Category Differences

Lacking health insurance and having public insurance were both positively associated with the prevalence of overweight in adolescents but not in children (Haas et al., 2003). Using the Medical Expenditure Panel Survey Household Component, Haas et al. (Haas et al., 2003) looked at overweight in children and adolescents and reported that BMI is related to SES as assessed by insurance category. This was the first study to show positive association between health insurance and weight status (Haas et al., 2003).

Oklahoma Socioeconomic Status

High prevalence of low socioeconomic status in Oklahoma children put children at risk for overweight. In 2004-2005, Oklahoma had approximately 3.4 million residents of which almost 1.4 million were at or below 200% of the national poverty level (Kaiser Family Foundation, 2007). According to the 2004-2005 Medicaid Fact Sheet for Oklahoma, the use of Medicaid was reported for 14.9% of Oklahomans and 19.2% of the Oklahoma population were uninsured (Kaiser Family Foundation, 2007). The state is comprised of approximately 899,300 children ages 18 years and below. Oklahoma has 283,680 of those children on Medicaid or 31% of the state's childhood population. An additional 130,780 children were uninsured or 15% of the state's child population (Kaiser Family Foundation, 2007).

Consequences of Childhood Overweight

Many consequences of overweight occur in children yet less than ten percent of health care practitioners look for health consequences when they screen for overweight in children (Barlow et al., 2002). History of overweight related conditions should be included when the HCP completes medical histories and physical exams of children including hypertension, endocrine disorders, orthopedic problems, T2DM, genetic syndromes, sleep disorders, pseudotumor cerebri, and gastrointestinal (GI) disorders. Biometric parameters include lipid profile, fasting insulin and glucose, glycosolated hemoglobin ($Hb_{A1c)}$, cortisol, liver enzymes and thyroid profile (Golay & Ybarra, 2005).

Type 2 Diabetes Mellitus (T2DM)

Once a disease of adults, the dramatic increase of T2DM in children and adolescents is an emerging health issue with overweight children or adolescents at twice the risk for T2DM as compared to normal weight children or adolescents (American Diabetic Association, 2000; Goodpaster & Wolf, 2004; Ogden et al., 2005; Reinehr, 2005). Diabetes in children has increased ten fold from 1982 to 1994 with 60-90% of all T2DM patients having been reported to be or have been obese, and 85% of children with T2DM are reported to be overweight or obese at diagnosis (American Diabetic Association, 2000; Golay & Ybarra, 2005; Ogden et al., 2006; Reinehr, 2005). The rising occurrence of T2DM was first recognized in the US in the 1990's when only 3% of new diabetes cases in children and adolescents were T2DM (American Diabetic Association, 2006; Barlow et al., 2002; Shafrir, 1992). Now as many as 45% of the new diabetes cases in patients 10-20 years of age depending on the ethnicity of the patient population are T2DM (Kibbe & Offner, 2003; National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), 2005). As prevalence and severity of overweight and obesity have increased in children and adolescents, T2DM is now appearing in children as young as eight years of age (Daaboul & Siverstein, 2004; Daniels, 2006).

Type 2 diabetes in children worldwide has been reported from developed countries such as the U.K., U.S., and Japan. The rising occurrence has been attributed to the increasing rate of obesity in children (National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), 2005). Increasing prevalence of diabetes has also been reported in Canada, Austria and Germany (Daaboul & Siverstein, 2004; Hannon, Rao, & Arslanian, 2005).

Economic, social, health, and psychological impact of diabetes are huge in the pediatric population (Daaboul & Siverstein, 2004). Children's risk for microvascular complications is higher because the longer they have diabetes the longer the disease can take its toll on the body (Burke, 2006; Daaboul & Siverstein, 2004). Intertwining obesity and diabetes symptoms have made the two twin diseases (Ogden et al., 2005; Shafrir, 1992). In adults, every kilogram of weight gain increases the risk for diabetes by 4.5% to 9% (American Diabetic Association, 2000; Shafrir, 1992). Although studies have not been reported for children, randomized controlled trials in adults have shown that T2DM can be prevented by lifestyle changes, such as regular physical activity, healthy diet and weight reduction (Borodulin et al., 2006).

T2DM presentation in children can be hidden. At-risk for overweight and overweight children diagnosed with T2DM often present with no glucose in the urine, no ketosis, and can typically have no outward symptoms for years. Polyuria or polydypsia are usually not present but may occur mildly. Typically random blood glucose or random urinalysis may show positive results for glucose (Daaboul & Siverstein, 2004). Acanthosis nigricans, a satin like hyperpigmentation appearing on the neck, underarms, or knuckles reported in as many as 90% of children with T2DM, has been used as a predictor of hyperinsulinemia (Goodpaster & Wolf, 2004). Its use as indicative hyperinsulinemia caused physicians to misdiagnose half of the children who had hyperinsulinemia (Goodpaster & Wolf, 2004).

The goals of the American Diabetic Associate for successful treatment for a child with T2DM is defined as cessation of excessive weight gain, normal linear growth, and attainment of fasting blood glucose levels less than 126 mg/dl and a Hb_{A1c} of less than 7% (Harrell et al., 2006). Children under age 7 with a BMI $\geq 95^{th}$% should maintain weight unless they have a secondary complication in which health care practitioners should assist the parents to help the child lose weight until BMI is $\leq$ the 85^{th} % (Harrell et al., 2006). The older a child becomes, the harder it is to lose weight (Harrell et al., 2006). Parents of children should work to incorporate a healthy family lifestyle including increased activity and appropriate food choices (Daaboul & Siverstein, 2004).

Obesity is reported to account for 50-55% of insulin resistance in T2DM (Ramachandran, Snehalatha, Satyavani, Sivasankari, & Vijay, 2003). The American Diabetes Association has reported that obese children have elevated insulin and 40% less glucose metabolism from insulin-stimulation (Daniels, 2006). Among children and adolescents it is suggested that fat accumulation especially abdominally is a major contributor to insulin resistance (Grundy, 2006). Insulin resistance which is the inability of the cell to take up glucose in response to insulin often precedes the development of T2DM in adults (Borodulin et al., 2006; Daaboul & Siverstein, 2004; Hannon et al., 2005). Longitudinal studies have shown that people with the genetic predisposition to impaired insulin secretion develop diabetes when they develop insulin resistance due to obesity (Hannon et al., 2005). ADA recommends screening all children with a BMI of $\geq$ 85% with two additional risk factors e.g. family history of T2DM, high blood pressure and ethnicity (American Diabetic Association, 2006; Daaboul & Siverstein, 2004).

Impaired Glucose Tolerance (IGT)

Pre-diabetic patients may have only impaired fasting glucose (IFG) or only IGT. Daaboul reported that insulin resistance and elevated insulin levels are present in pre-diabetic conditions (American Diabetic Association, 2006) which includes impaired glucose tolerance. IGT is defined as a two hour post prandial glucose reading of greater than 140mg/dl but less than 199 mg/dl (Grundy, 2006). IFG is defined as plasma glucose values greater than 100mg/dl but less than 126 mg/dl (Alexander, Landsman, & Grundy, 2006; Barkai & Paragh, 2006; Grundy, 2006). Pre-diabetes and T2DM are important risk factors for premature death and cardiovascular disease (Hirschler et al., 2005).

Metabolic Syndrome

The term 'metabolic syndrome' was created to describe a clustering of risk factors associated with both T2DM and cardiovascular disease which now affects one-fourth of the American adult population (Hannon et al., 2005; Harrell et al., 2006). It was the field of diabetes that changed Reaven's term syndrome X and the term 'insulin resistance syndrome' to the more generic name of metabolic syndrome (Harrell et al., 2006). Metabolic syndrome was defined by the Adult Treatment Panel III (ATP III) to be the existence of any three out of five criteria including: increased WC (parameter of abdominal obesity), elevated triglycerides, reduced HDL cholesterol, elevated blood pressure, or elevated glucose (Daniels, 2006). In children, however, the definition of metabolic syndrome is not as clear (Daniels, 2006; Malecka-Tendera & Mazur, 2006).

Factors of metabolic syndrome are increasingly observed in children (Daniels, 2006; Harrell et al., 2006). Cook et al. reported metabolic syndrome in only 4% of children of mixed weights but in 30% of obese children (Cussons, Stuckey, & Watts, 2006; Daniels, 2006). Cook et al. also found each half-unit increase in BMI *z*-score was associated with a 50% increase in risk for metabolic syndrome in children (Cussons et al., 2006; Daniels, 2006). Using the NHANES III data set, Cook et al. reported a 4.2% prevalence of metabolic syndrome among children and adolescents (Barlow et al., 2002). In a study of 4-20 year old children with moderate and severe obesity, the presence of metabolic syndrome was reported in 38.7% and 49.7%, respectively (Harrell et al., 2006).

Cardiovascular Disease and Hypertension

Childhood obesity damages body organs and childhood overweight may accelerate the development of cardiovascular disease (Barlow et al., 2002; Kibbe & Offner, 2003). Overweight adolescents have 2-3 times the risk of coronary heart disease (Canty, 2003). Twenty percent of 5-11 year old overweight children have hypertension and both overweight children and adolescents are more likely to develop hypertension as adults (Burke, 2006; Daniels, 2006). While the symptoms of cardiovascular disease may not appear during childhood, weight problems in childhood can cause early onset heart disease (Canty, 2003). Blood pressure and lipid profiles should randomly be assessed since obesity induced increased vasculature and decreased exercise often lead to hypercholesterolemia and hyperinsulinimia (Burke, 2006). Fifty percent of childhood hypertension is due to obesity.

Obesity in children is associated with higher blood pressure (BP) and family history of hypertension is an important predictor of BP in children (Burke, 2006; Daniels, 2006). In the Study of Perth Lifestyle and Skin Health (SPLASH) study, the highest percentile of BP for 9-18 year old children was among those with a family history of hypertension and those who were overweight (Daniels, 2006). The Raine cohort as well as other studies reported a significant increase of blood pressure among those with higher adiposity, which can be seen as early as one year of age (Burke, 2006; Hannon et al., 2005). In adults, even a small weight gain of five pounds between the ages of 20-50, may increase the risk of chronic disease and may negatively affect heart disease status (Burke, 2006).

Obesity is detrimental to the heart and blood vessels even in very young children (Cash et al., 2004; Hannon et al., 2005). The Bogalusa Heart study and the Pathobiologic Determinants of Atherosclerosis in Youth (PDAY) both used autopsy reports to show that adolescents and young adults who died accidentally had fatty streaks and fibrous plaques (Daniels, 2006). Both studies showed body adiposity was significantly related to the presence of atherosclerotic lesions (Daniels, 2006).

Children and adolescents with T2DM may experience diabetic microvascular and macrovascular complications at younger ages than individuals who develop diabetes in adulthood. These complications include atherosclerotic cardiovascular disease, stroke, myocardial infarction, and sudden death; renal insufficiency and chronic renal failure; limb-threatening neuropathy and retinopathy leading to blindness (Daniels, 2006).

Left Ventricular Mass

Increases of the left ventricular mass were shown in obese children which would carry into adult life (Li, Campbell, & Tutor, 2004). Because the heart pumps blood through the veins, obesity and overweight increase the length of vasculature resulting in increasing pressure on the heart. The heart compensates by increasing its left ventricular mass. Added to stress on the heart, blood pressure is elevated as the heart attempts to carry blood (Daniels, 2006). Children at $\geq$ the 90th BMI centile have 2.5 to 3.7 times higher blood pressure compared to children at the 10th BMI centile (Burke, 2006; Daniels, 2006). Blood pressure has increased in children over past decades. Moreover, as BMI increases, the children are at higher risk for developing hypertension as adults (American Academy of Pediatrics, 2003; Daniels, 2006). Fat mass and systolic blood pressure are strongly related to left ventricular size which could be an important factor in the pathology of cardiovascular risk in children with increased adiposity (Daniels, 2006; Malecka-Tendera & Mazur, 2006).

Breathing Problems

The pulmonary system which takes in air and exchanges carbon dioxide for fresh oxygen is affected by overweight and obesity. The incidence of asthma, a very common childhood disease, has paralleled the increasing prevalence and severity of childhood obesity over the past twenty years (Barlow et al., 2002; Daniels, 2006). It is not known if the increase in asthma is due to other factors such as smoking, decreased physical activity, or environmental factors. However, it is known that excess abdominal fat can alter lung function both by increasing weight on the wall of muscle and bone that surround the lungs and by limiting the motion of the diaphragm (Barlow et al., 2002). Obstructive sleep arousal or sleep apnea and obesity hypoventilation syndrome affect overweight children and are life-threatening conditions (Daniels, 2006). One third of severely overweight children have been reported to have severe obstructive sleep apnea (American Academy of Pediatrics, 2003; Canty, 2003; Daniels, 2006).

Non-alcoholic Fatty Liver Disease

Once thought to be a complication of adult obesity, researchers now are reporting fatty livers in children. Ten to thirty percent of obese children have elevated liver enzymes such as aminotransferases suggesting steatosis or fatty liver disease (Daniels, 2006). As obesity develops, fat fills the adipose cell and then can be deposited in the liver. Estimates are that as many as 50% of obese children may have fat deposits in their livers while some 3% of obese children have the more advanced nonalcoholic steatohepatitis, with the highest risk being in males and Hispanics (Daniels, 2006).

Gastroesophageal Reflux Disease (GERDS)

Research has verified obesity can contribute to reflux, which is stomach's contents flowing up into the esophagus, causing symptoms of acute heartburn and damage of the esophageal lining (Canty, 2003; Daniels, 2006). GERDS occurs in obese adults three times as often as in normal weight adults, although GERDS does occur in children they have not been studied extensively enough to draw conclusions on obesity relation (Daniels, 2006).

Orthopedic Problems

Excess weight on children's bones cause many orthopedic problems. Blount disease which is also known as tibia vera, is a condition where the growth plate of the medial tibia begins to bow due to excessive weight (American Academy of Pediatrics, 2003; Barlow et al., 2002; Canty, 2003). Bowing causes an abnormal gait and affects more males over the age of nine (Daniels, 2006). The second most common bone challenge for overweight children is the slippage of capital femoral epiphysis (Daniels, 2006). This usually occurs around the age of skeletal maturity and causes rotation of the upper leg and hip preventing the child from walking and requires surgical intervention (Canty, 2003; Cash et al., 2004; Daniels, 2006). This problem occurs primarily in African Americans and more common in males (Daniels, 2006).

Depression/Psychosocial

Depression is a common mental health problem in adolescents and weight issues often add to body dissatisfaction (Daniels, 2006). While studies are small, Siegel showed that African American girls have a more positive body image than white, Hispanic and Asian girls (Cash et al., 2004). He also found that African American girls' body image is less affected by their weight (Daniels, 2006) while Cash found African American children had more emotional and behavioral problems at home and school when overweight (Ogden et al., 2005). Studies on depression have been unable to determine if the depressive symptoms are based on the severity of the weight (Cash et al., 2004; Ogden et al., 2006). Depression could be the cause of overweight with associated abnormal eating patterns and altered physical activity or overweight could be the cause of depression with altered self-image (Daniels, 2006). Obese children were approximately six times more likely to report impaired psychosocial function than healthy weight children (Center for Disease Control's Behavioral Risk Factor Surveillance System, 2006).

CHAPTER III

METHODOLOGY

Purpose

This descriptive retrospective study was conducted to evaluate the prevalence of overweight and at-risk for overweight in 4-6 year old children seen in a northeastern Oklahoma pediatric clinic. This study evaluated if there were differences in the distribution of children in the four weight categories of underweight, normal weight, at-risk for overweight, and overweight by gender, insurance type or biennial exam year category. This study also evaluated if there was a difference in this cohort of children by BMI z-scores by gender, insurance type or biennial exam year category. The findings of this study are the first step toward the development of programs and services to better serve these families and the children.

Design, Setting, and Participants

The medical charts of approximately fifteen hundred families were reviewed retrospectively. Anthropometric parameters of well 4-6 year old children with clear insurance classification during the kindergarten check-up from 1999-2006 were included in the study. The exam closest to age five was selected if more than one exam occurred during the referenced time period for the same child. An Excel flowchart was created to record the raw data (Appendix 2). Each child's data was assigned a number; their gender insurance categories were coded. Government assisted medical insurance included but was not limited to Sooner Care, DHHS-EDH custody, foster care, and Welfare-Title 19. Growth parameters were recorded as height in inches, weight in pounds, and BMI was calculated by the formula

$$\text{BMI} = \frac{\text{weight in inches}}{\text{height in inches}^2} \times 703.$$

Data were uploaded into an Access database then into the CDC's Epi-Info®, (http://www.cdc.gov/EpiInfo/). Epi-Info® calculated CDC's 2000 BMI percentiles which were both age and gender specific for the classification of the four weight categories: underweight (less than the 5%), normal weight, at-risk for overweight ($\geq 85^{th}$ percentile), and overweight ($\geq 95^{th}$ percentile). Epi-Info® also calculated BMI z-scores.

Date of birth and date of service were originally recorded to provide precise age for BMI percentiles. After uploading data into Epi-Info®, the dates of birth and service were blinded for HIPPA compliance. The dates of service were manually changed to a biennial exam year category. For confidentiality, raw data were kept on a removable thumb drive which remained inside the pediatric clinic. The Epi-Info® BMI percentile information and BMI *z*-scores along with weight, height and exam year were uploaded into an Excel file for statistical analyses.

Preliminary data collections were completed by the primary investigator to check for technique and sample size within insurance categories. The completed data collection; however, was conducted by employees of the pediatric clinic. All anthropometric measurements were performed by licensed medical professionals. Children were weighed on the same scale which was calibrated daily.

Statistical Analyses

Data were analyzed using the PC Statistical Analysis System (SAS) software program for Windows (Version 9.1, SAS Inst. Inc., Cary, NC). FREQ procedures were used to determine frequency distributions and Chi-square analyses were used to evaluate the distribution of children classified as underweight, normal weight, at-risk for overweight and overweight by gender, insurance type and biennial exam year categories. T-test procedure was used to evaluate BMI z-score by gender. GLM procedure was used to evaluate BMI *z*-scores by both insurance type and biennial exam year categories. Signifance level was set at P value ≤ 0.05.

CHAPTER IV

RESULTS

The medical charts of approximately fifteen hundred families were reviewed for complete anthropometric parameters of height and weight of children who visited the clinic from 1999 to 2006 for a kindergarten check-up. Completed anthropometric parameters and clear insurance status were obtained from 728 children, 4-6 years of age, at the time of the check-up. Demographic characteristics of these children are reported in **Table 4**. Male children comprised 55.5% (n=404) of the total subjects while females comprised 44.5% (n=324). The majority of the children had private insurance (85.6%, n=623); while uninsured self-pay and government-assisted accounted for 6.9% (n=50) and 7.5% (n=55), respectively. Data were also sorted by biennial exam year categories corresponding to NHANES data collection. The number of 4-6 year old children by biennial exam year categories in 1999-2000, 2001-2002, 2003-2004 and 2005-2006 were 21% (n=151), 25% (n=182), 33% (n=242), and 21% (n=153), respectively. Approximately 78% (n=565) of the children were classified as normal weight; while 4.7% (n=34), 10% (n=73), 7.7% (n=56) were classified as underweight, at-risk for overweight or overweight, respectively.

Data were also analyzed by gender (**Table 5**). Among male children, 83.9% (n=339) had private insurance, 7.9% (n=32) had self-pay for services, and 8.2% (n=33) had government assistance. Similar trends were observed for female children with 87.7% (n=284), 5.6% (n=18), and 6.7% (n=22) being privately insured, self-pay or government assisted, respectively. The highest number of males and females were seen in the clinic in 2003-2004 (approximately 33%).

The majority of males and females seen in the clinic were classified as normal weight (approximately 77%, n=311 and 78.4, n=254 for males and females, respectively). Approximately 5.4% (n=22), 10.9% (n=44) and 6.7% (n=27) of male children were classified as underweight, at-risk for overweight, and overweight, respectively **(Table 5)**. A similar distribution was observed in female children with 3.6% (n=12) being classified as underweight and the same number of children (9.0%, n=29) being classified as at-risk for overweight and overweight.

Chi-square analyses were performed to determine if there were differences in the distribution of children in BMI weight categories by gender, insurance type and biennial exam year categories (**Table 6**). There were no significant differences in the distribution of BMI weight categories by gender and by biennial exam year categories. For insurance categories, cell sizes were too small for the Chi square analyses to be valid (**Table 6**). For children with private insurance, 4.8% (n=30), 79.3% (n=494), 9.6% (n=60), 6.3% (n=39) were classified as underweight, normal weight, at-risk for overweight, and overweight, respectively. For the uninsured self-pay children, 4.0% (n=2), 68% (n=34), 8.9% (n=4), 20% (n=10) were classified as the underweight, normal weight, at-risk for overweight, and overweight, respectively. For government-assisted children, 3.6% (n=2), 67.3%

(n=37), 16.4% (n=9), 12.7 (n=7) were classified as underweight, normal weight, at-risk for overweight, and overweight, respectively.

T-test was used to evaluate BMI z-scores by gender (**Table 7**). The mean BMI z-score was 0.102 for males and 0.224 for females. No significant difference was observed in BMI *z*-score by gender.

General linear model (GLM) was used to evaluate BMI z-scores by insurance type and biennial exam year categories (**Table 8**). The mean BMI z-score of children with private insurance was significantly less (*P*=0.0016) than the mean BMI z-score of self-pay and government-assisted children**.** BMI z-score of self-pay and government-assisted children were not significantly different from each other. Mean BMI z-scores were not significantly different by biennial exam year categories..

CHAPTER V

DISCUSSION

Childhood overweight is increasingly becoming a major problem in the US and in Oklahoma. Addressing obesity at the kindergarten level is a good place to start because NHANES I-III reported the sharpest increase in overweight among 4-5 year olds (Nicklas & Johnson, 2001). The purpose of this study was to evaluate the prevalence of at-risk for overweight and overweight in 4-6 year old children seen at a northeastern Oklahoma pediatric clinic. The findings of this study will assist the clinic in the development of suitable intervention programs and services.

The results of this study indicate the majority of children (approximately 80%) were classified in the healthy weight category **(Table 4)**. Children who were at-risk for overweight account for 10% of the study population and 7.7% were classified as overweight based on kindergarten check-ups from 1999-2006. One interesting observation from this study was the number of underweight children (4.7%). One possible explanation for the number of underweight children is food insecurity. It has been reported that 11% of American families suffer at some point in time from food insecurities (Nicklas & Johnson, 2001). African Americans and Hispanic Americans have three times the risk of food insecurities and single mother families have six times the risk of food insecurities (Barlow et al., 2007). Because underweight is not a focus of this study, future studies need to further investigate this weight category.

Our findings show a lower percentage of at-risk for overweight and overweight children by biennial exam year category **(Table 6)** compared to NHANES IV **(Table 1)**. NHANES IV reported an increasing percentage of at-risk for overweight and overweight 2-5 year old children (22.0%, 23.5% and 26.2% for 1999-2000, 2001-2002, and 2003-2004, respectively). Our data showed a decreasing percentage of children classified as at-risk of overweight and overweight (20.6%, 17.0% and 15.3%, respectively for the same years). The same trend was observed when looking at the overweight category alone. NHANES IV **(Tables 1 and 6)** reported 10.3%, 10.6%, and 13.9% overweight 2-5 year old children while our data showed decreasing trends of 9.3%, 7.7%, 6.2%, respectively for the same reporting years. Reasons for the discrepancy in our data with NHANES IV could be differences in ethnicity and SES. NHANES IV had over sampling of Mexican Americans and non-Hispanic black in their population but the majority of our clinic's clientele are Caucasians based on general observation (Ogden, Flegal, Carroll, & Johnson, 2002). However, ethnicity was not a parameter assessed in this study. Socioeconomic status is evenly distributed in the nationally representative NHANES IV while most of our subjects were presumably on the higher SES category. Approximately 86% of our children have private insurance (Katherine M. Flegal et al., 2006).

Aside from NHANES, the percentage of children in the present study classified as overweight and at-risk for overweight was also lower than the 28% reported by Moore et al. (2004) conducted with southwestern Oklahoma children (Oklahoma Institute for Child Advocacy, 2005). The discrepancy between our study and that of Moore et al. (2004)

may be in part due to differences in study site and the clinic having a health coach on staff who provided educational materials such as hand-outs and materials posted on bulletins boards.

When the data from our study were analyzed by gender **(Table 6)**, although not statistically significant, there were more females classified as overweight (8.9% vs. 6.7%) while more males were at-risk of overweight (10.9% vs. 9.0%). These observations are different from the findings of CDC **(Table 2)** which reported the prevalence of overweight and risk of overweight in 2-5 year old boys is equal to or greater than girls beginning in 2001. Li et al. showed males had a higher prevalence of overweight (Department of Health and Human Services & Centers for Disease Control and Prevention, 2007b; Li et al., 2004). However, an earlier study by Ogden et al. (1999-2000) reported more 2-5 year old girls were at-risk for overweight or overweight than boys. In addition, a study by Gordon-Larsen et al. (2003) reported a higher incidence of overweight among teenage girls than teenage boys (Department of Health and Human Services & Centers for Disease Control and Prevention, 2007b; Gordon-Larsen et al., 2003). It is not clear whether the trend observed in our study of more girls compared to boys being classified as overweight will continue to their adolescent years.

Another objective of this study was to evaluate the distribution of children in the four weight categories by insurance type **(Table 6)**. A major limitation of this study, as mentioned earlier, was the use of insurance as a measure of at-risk of overweight and overweight. However the findings of Haas (Haas et al., 2003) showed insurance type did relate positively to weight distribution even though it may not truly reflect socioeconomic status. Clear insurance status was difficult to assess and should be followed up with a validated questionnaire which includes income and insurance type questions (Department of Health and Human Services & Centers for Disease Control and Prevention, 2007b; Oklahoma Institute for Child Advocacy, 2005). Future studies should include a clinic which specializes in lower SES families such as WIC clinic or another government-assisted clinic. Another difficulty evaluating the true relationship of BMI percentile by insurance category was due to the majority of children in our clinic (approximately 80%) being privately insured **(Table 4)**.

BMI *z*-scores were also evaluated by gender **(Table 7)**, insurance type and biennial exam year category **(Table 8)**. There were no significant differences in BMI *z*-scores by gender and biennial exam year. A significant increase (P = 0.0016) in BMI *z*-scores for uninsured self-pay and government-assisted children was observed compared to children with private insurance.

Aside from having too few government-assisted and self-paying children, another limitation of the study was the lack of ethnicity data from the medical chart which makes it hard to compare our results with national statistics. Most national studies evaluated the relationship of SES with overweight and at-risk of overweight among children of different ethnic backgrounds.

Future studies should (1) address ethnicity and rebound adiposity age, (2) focus in northeastern Oklahoma area clinics which have no wellness education and have a higher percent of government assisted clientele, and (3) evaluate SES with a validated questionnaire including family history, income, parental education, specific government assistance programs and willingness to promote a healthy lifestyle.

CHAPTER VI

SUMMARY

This descriptive retrospective study was conducted to evaluate the prevalence of overweight and at-risk for overweight in 4-6 year old children seen in a northeastern Oklahoma pediatric clinic. This study evaluated if there were differences in the distribution of children in the four weight categories of underweight, normal weight, at-risk for overweight, and overweight by gender, insurance type or biennial exam year category. This study also evaluated if there was a difference in this cohort of children by body mass index (BMI) *z*-scores by gender, insurance type or biennial exam year category. The findings of this study were the first step toward the development of programs and services to better serve these families and the children.

The objectives included:

1. To determine BMI percentiles and BMI *z*-scores of kindergarten and pre-kindergarten children seen from 1999-2006 at a northeastern Oklahoma pediatric office.
2. To determine if there is a difference in the distribution of underweight, normal weight, at-risk for overweight and overweight in this cohort of children by gender, insurance type and biennial exam year categories in this cohort of children.

The null hypotheses are:

Ho1. There will be no significant difference in the distribution of children classified as underweight, normal weight, at-risk of overweight, and overweight by gender, insurance type or biennial exam year category. The null hypothesis was accepted for gender differences, insurance type and biennial exam year categories.

Ho2. There will be no significant difference in children's BMI z-scores by gender, insurance type, or biennial exam year category. The null hypothesis was accepted for gender and biennial exam year categories but was rejected for insurance type.

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APPENDIX

Oklahoma State University Institutional Review Board

Date:	Wednesday, February 14, 2007
IRB Application No	HE078
Proposal Title:	Relationship of Socioeconomic Status and Anthropometric Parameters in Boys and Girls (Age 4.0 - 6.5 years)
Reviewed and Processed as:	Exempt

Status Recommended by Reviewer(s): Approved Protocol Expires: 2/13/2008

Principal Investigator(s

Debra Beistle Schroeder 6010 S. Quebec Ave. Tulsa, OK 74135	Edralin A. Lucas 422 HES Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☐ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 219 Cordell North (phone: 405-744-5700, beth.mcternan@okstate.edu).

Sincerely,

Sue C Jacobs

Sue C. Jacobs, Chair
Institutional Review Board

Table 1. Prevalence of Overweight and At-risk of Overweight Among US Children Ages 2-5 and 6-11 From NHANES I to NHANES IV (American Obesity Association, 2005; Ogden et al., 2006) [1]

Age (years)	**NHANES I 1963-65 1966-70[2]**	**NHANES II 1971-74**	**NHANES III 1976-80**	**NHANES IV 1988-94**	**NHANES IV 1999-2000**	**NHANES IV 2001-02**	**NHANES IV 2003-04**
Overweight							
2-5	-	5	5	7.2	10.3	10.6	13.9
6-11	4.2	4	6.5	11.3	15.1	16.3	18.8
At-risk for overweight and overweight							
2-5	-	-	-	-	22.0	23.5	26.2
6-11	-	-	-	-	29.8	32.2	37.2

[1]NHANES- National Health and Nutrition Examination Survey

[2]Data for 1963-65 are for children 6-11 years of age; data for 1966-70 are for adolescents 12-17 years of age, not 12-19 years.

Table 2. Prevalence (%) of At-risk for Overweight and Overweight in 2-19 and 2-5 Year Old Boys and Girls Divided According to NHANES IV Biennial Year Category (Cash et al., 2004)[1]

Year Category	Male (2-19 Yr)	Male (2-5 Yr)	Female (2-19 Yr)	Female (2-5 Yr)
At-risk for overweight				
1999-2000	**28.9**	21.9	27.4	**22.2**
2001-2002	**30.6**	**24.2**	29.4	22.8
2003-2004	**34.8**	**27.3**	32.4	25.2
Overweight				
1999-2000	**14.0**	9.5	13.8	**11.2**
2001-2002	**16.4**	**10.7**	14.4	10.5
2003-2004	**18.2**	**15.1**	16.0	12.6

[1]NHANES- National Health and Nutrition Examination Survey

Table 3. Comparative CDC Categories of Weight in Adults and Children (Katherine M. Flegal et al., 2006)[1]

Category	**Adults (21+ years)**	**Children (2-20 years)**
Underweight	BMI $\leq$ 18.5	<5th BMI-for-age percentile
Normal weight	BMI $\geq$ 18.5- 24.9	BMI-for-age $\geq$ 5% to <85%
At-risk for overweight	Not used with adults	BMI-for-age $\geq$85% to < 95%
Overweight	BMI $\geq$25-29.9	BMI-for-age $\geq$95%
Obesity	BMI $\geq$ 30-39.9	Not currently used in children[2]
Extreme Obesity	BMI $\geq$ 40	Not currently used in children[2]

[1]Not always used by scientists

[2]Secondary parameters by health care practitioners must be used to assess childhood obesity.

Table 4. Characteristics of 4-6 Year Old Children Who Visited One Northeastern Oklahoma Pediatric Clinic by Gender, Insurance Type, Biennial Exam Year Category and BMI Weight Category

Gender	Frequency (n)	Percent of Total Subjects
Male	404	55.5
Female	324	44.5
Insurance Type		
Insured	623	85.6
Self-pay (uninsured)	50	6.9
Gov assistance	55	7.5
Biennial Exam Year Category		
1999-2000	151	20.8
2001-2002	182	25.0
2003-2004	242	33.2
2005-2006	153	21.0
BMI Category		
Underweight	34	4.7
Normal wt	565	77.6
At-risk	73	10.0
Overweight	56	7.7

Table 5. Gender Frequency of 4-6 Year Old Children Seen in a Northeastern Oklahoma Pediatric Clinic by Insurance, Biennial Exam Year, and BMI Weight Categories

Insurance Type	**Number of Male Children**	**% of Total Male Children**	**Number of Female Children**	**% of Total Female Children**
Insured	339	83.9	284	87.7
Self-pay (uninsured)	32	7.9	18	5.6
Gov assistance	33	8.2	22	6.7
Biennial Exam Year Category				
1999-2000	84	20.8	67	20.7
2001-2002	102	25.2	80	24.7
2003-2004	132	32.7	110	33.9
2005-2006	86	21.3	67	20.7
BMI Category				
Underweight	22	5.4	12	3.6
Normal wt	311	77.0	254	78.4
At-risk	44	10.9	29	9.0
Overweight	27	6.7	29	9.0

Table 6. Chi-Square Analyses Comparing Distribution of the Different BMI Categories by Gender, Insurance and Biennial Exam Year Categories

Gender	**BMI% Underweight (n)**	**BMI% Healthy weight (n)**	**BMI% At-risk for overweight (n)**	**BMI% Overweight (n)**	**Chi-square**	***P* value**
Male	5.4% (22)	77.0% (311)	10.9% (44)	6.7% (27)	3.0914	0.3778
Female	3.7% (12)	78.4% (254)	9.0% (29)	8.9% (29)		
Insurance Type						
Insured	4.8% (30)	79.3% (494)	9.6% (60)	6.3% (39)	17.6068	0.0073*
Self-pay	4.0% (2)	68.0% (34)	8.9% (4)	20.0% (10)		
Gov Assist	3.6% (2)	67.3% (37)	16.4% (9)	12.7% (7)		
Biennial Exam Year Category						
1999-2000	5.3% (8)	74.1% (112)	11.3% (17)	9.3% (14)	4.5003	0.8755
2001-2002	5.0% (9)	78.0% (142)	9.3% (17)	7.7% (14)		
2003-2004	3.3% (8)	81.4% (197)	9.1% (22)	6.2% (15)		
2005-2006	5.9% (9)	74.5% (114)	11.1% (17)	8.5% (13)		

* Chi square analysis may not be a valid test as 33% of the cells have counts less than 5.

Table 7. T-test on BMI z-scores of 4-6 Year Old Children Seen in a Northeastern Oklahoma Pediatric Clinic by Gender

Gender	Mean ±SE	n	*P* value
Male	0.102 ± 0.055	404	0.1345
Female	0.224 ± 0.060	324	

Table 8. BMI z-score of 4-6 Year Old Children Seen in a Northeastern Oklahoma Pediatric Clinic By Insurance, and Biennial Exam Year Categories Using GLM Procedure

Insurance Type	**Mean± SE**	**N**	***P* value**
Private	0.097 ± 0.043^{a}	623	0.0016
Self-pay	0.529 ± 0.153^{b}	50	
Government Assisted	0.490 ± 0.146^{b}	55	
Biennial Exam Year Category			
1999-2000	0.245 ± 0.089^{a}	151	0.7113
2001-2002	0.110 ± 0.081^{a}	182	
2003-2004	0.142 ± 0.070^{a}	242	
2005-2006	0.144 ± 0.088^{a}	153	

[a, b] Values which do not share the same letters are significantly different ($P<0.05$) from each other.

Table 9. Raw Data Form: Differences in Anthropometrics Parameters Of 4-6 Year Old Children Seen In A Northeastern Oklahoma Pediatric Clinic

Sex Code	**Insurance code**
Boys-1	private insurance=1
girls=2	self-pay=2
	government assistance=3

#	Sex	Insurance	**Birthdate**	**Service Date**	**Age**	**Height**	**Weight**	**BMI**	
1	1	3	1/1/1993	12/29/1999	6.99	47.25	57.00	17.95	
2	2	1	3/19/1993	4/8/1998	5.06	42.00	41.00	16.34	out service range
3	1	1	3/22/1993	7/27/1998	5.35	45.00	40.50	14.06	out service range
4	2	1	5/12/1993	6/2/1998	5.06	43.00	37.00	14.07	out service range
5	2	1	6/5/1993	5/19/2000	6.96	49.00	51.00	14.93	

Figure 1: Body Mass Index-for-Age Percentiles for 2-20 Year Old Boys

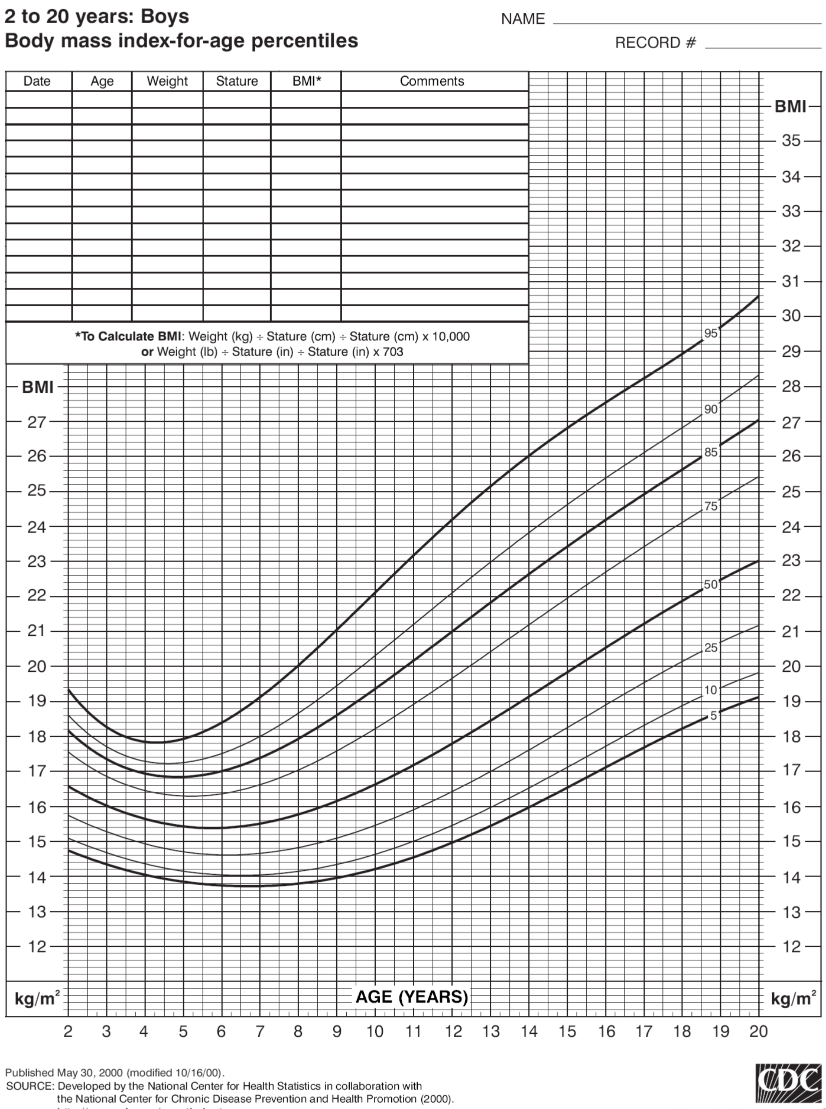


Figure 2: Body Mass Index-for-Age Percentiles For 2-20 Year Old Girls

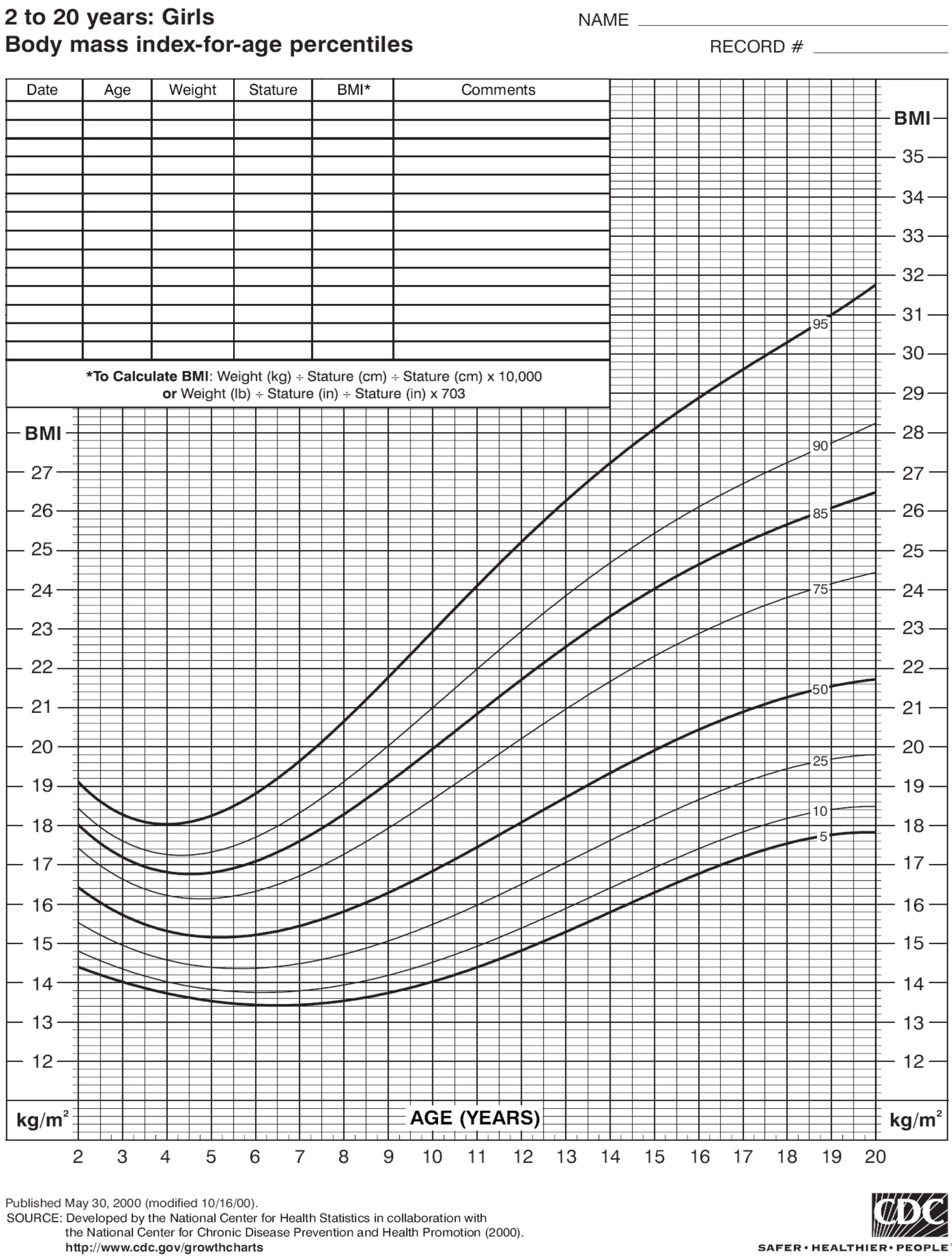


Figure 3. Body Mass Index Chart Showing Difference in the BMI Category for Two Children of the Same BMI but Different Age .

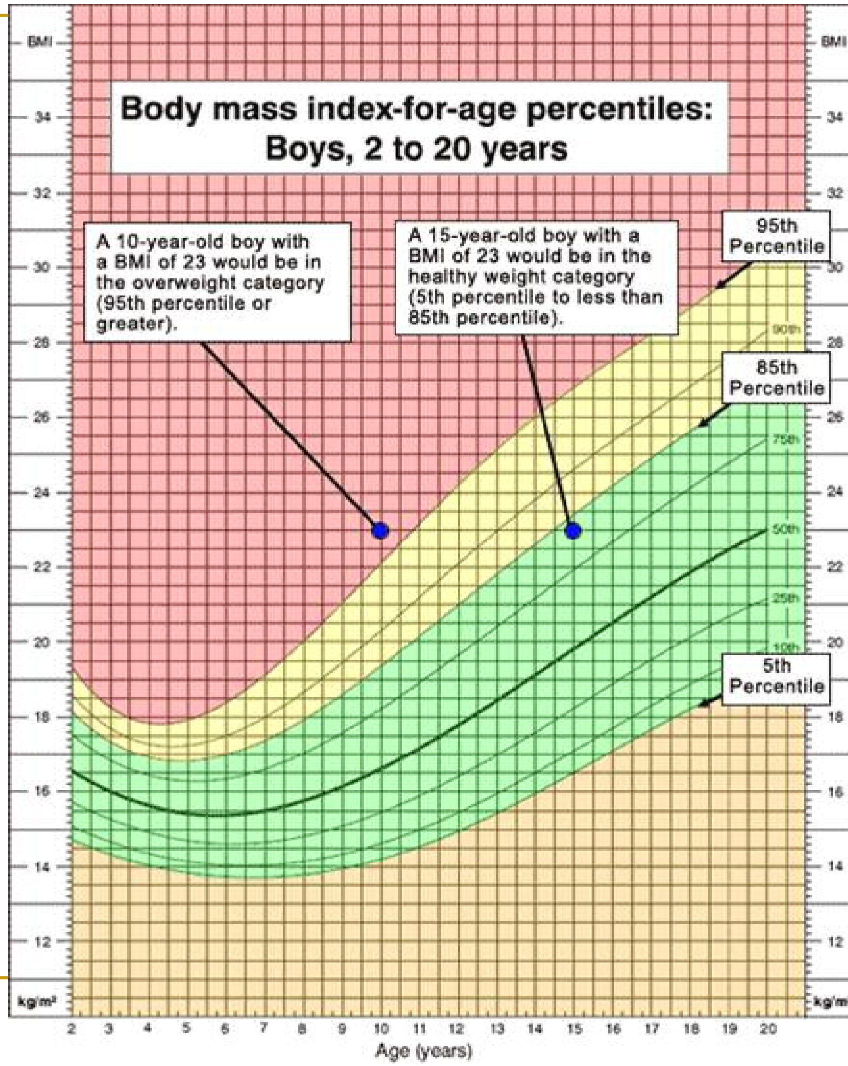
Childhood BMI Status

English Formula for BMI= [Weight in pounds / [Height in inches]^2 x 703

Metric Formula for BMI= Weight in kilograms / [Height in meters]^2

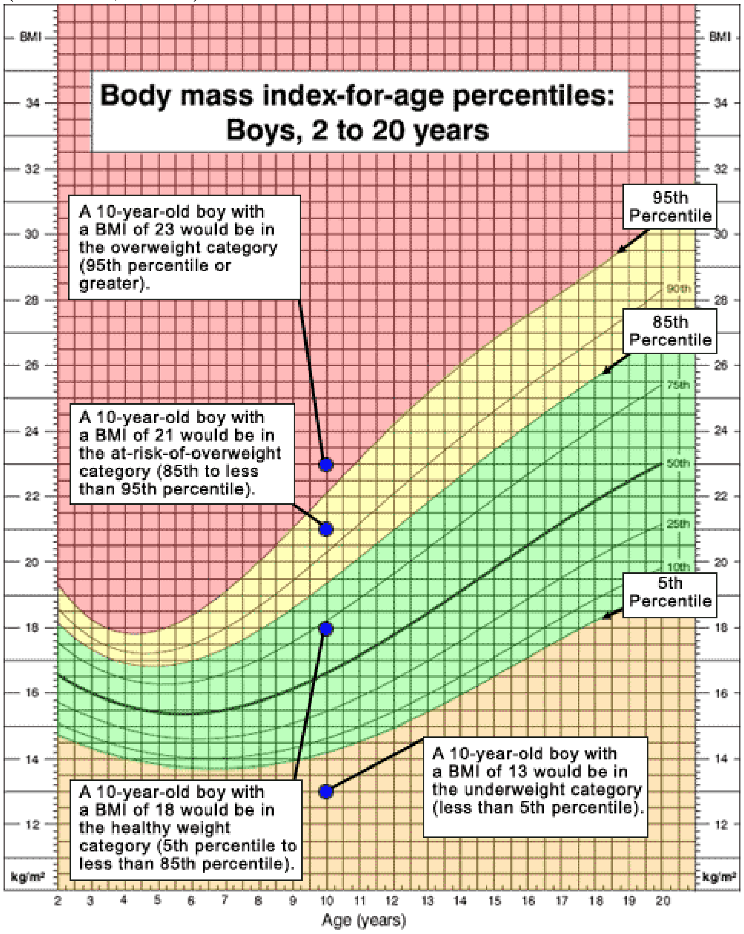
At-risk for overweight $\geq$85%

Overweight $\geq$ 95%



***BMI of 23 is Categorized Differently for a 10 and 15 Year Old Boy**

Figure 4. Body Mass Index Chart Showing the Different BMI Categories of a 10 Year Old Boy (de Onis, 2004)



VITA

Debra Beistle Schroeder, RN

Candidate for the Degree of

Master of Science

Thesis: DIFFERENCES IN ANTHROPOMETRIC PARAMETERS OF 4-6 YEAR OLD CHILDREN SEEN IN A NORTHEASTERN OKLAHOMA PEDIATRIC CLINIC

Major Field: Nutritional Science

Biographical:

Personal Data: Born in Ponca City, Oklahoma, married to Kent Schroeder, and is a mother of four children.

Education: Graduated from Norman High School, Norman, Oklahoma in May 1976; received Bachelor of Science in Nursing from East Central University, Ada, Oklahoma in May 1980, Presidential Leadership Class (1976-1980), Who's Who in American Colleges & Universities (1978-1980), National Student Nursing Association, Director of Education (1979-1980), Oklahoma Nursing Student Association, Legislative Director (1978-1979), ECU Student Senate (1976-1978); completed the requirements for the Master of Science degree with a major in Nutrition at Oklahoma State University in May 2007, Winterfeldt Graduate Research Scholarship, Phi Kappa Phi Honor Society

Experience: Worked as a wellness consultant for Decisions, August 1988 –Present. Consulted for several hospitals and clinics during the past 20 years while running her wellness business. (Carl Pfanstiel and Associates, Tulsa Pediatric Clinic, Hillcrest Health Care System's Children's Medical Center South Satellite Pediatric/Adolescent Psychiatric Unit; Oklahoma Osteopathic Hospital's ICU; Children's Medical Center's Pediatric Medical Unit; Hillcrest Medical Center MICU; and Pediatrics of Ada). Mrs. Schroeder is a Basic Life Support and Breast Feeding Educator, as well as active in the community with scouting and her church work.

Name: Debra Beistle Schroeder Date of Degree: July 2007

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: DIFFERENCES IN ANTHROPOMETRIC PARAMETERS OF 4-6 YEAR OLD CHILDREN SEEN IN A NORTHEASTERN OKLAHOMA PEDIATRIC CLINIC

Pages in Study: 58 Candidate for the Degree of Master of Science

Major Field: Nutritional Sciences

Scope and Method of Study: This study evaluated differences in the distribution of 4-6 year old children seen in a northeastern Oklahoma pediatric clinic by anthropometric parameter for four weight categories of underweight, normal weight, at-risk for overweight, and overweight by gender, insurance type, or biennial exam year categories. This study also evaluated if there was a difference in the frequency distribution of this cohort of children by weight category and body mass index (BMI) z-scores difference by gender, insurance type or biennial exam year category. The assessment of the findings in this study is a first step toward the development of programs and services to better serve these families and the children.

Findings and Conclusions:
The majority of the children in the clinic had normal weight (80%). Approximately 4.7%, 10%, and 7.7% of the children were underweight, at-risk for overweight, and overweight, respectively. The prevalence of at-risk of overweight and overweight children was lower than the national average. Mean BMI z-score of self-pay and government assisted children were significantly higher than those with private insurance. The relation of BMI and insurance status was hard to evaluate because of the small number of children in the self-pay and government assisted categories, therefore the findings on the relation between BMI and insurance category needs to be interpreted with caution.

ADVISER'S APPROVAL: Edralin A. Lucas